REMARKS

Claims 1, 2, 4-6, 8 and 31- 46, are all the claims presently being examined in this application. Applicant respectfully cancels claims 3 and 7, without prejudice or disclaimer. Claim 46 stands rejected upon informalities under 35 U.S.C. § 112, second paragraph. Regarding claim 46, the Examiner has thoughtfully provided the Applicant on March 10, 2004, with an article entitled, "Effects of Slurry Formation on Chemical-Mechanical Polishing of Low Dielectric Constant Polysiloxanes: Hydrido-Organo Siloxane and Methyl Silsesquioxane," J.Vac.. Sci. Technol. B 18(1), Jan/Feb 2000.

Claims 1, 4-5, 8, 34, 37, 38, and 41-44 stand rejected under 35 U.S.C. § 102(e) as being unpatentable over Lu, et al. (U.S. Patent No. 6,008,540). Claims 2, 6 and 31-32 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Lu ('540) and further in view of the applicant's admitted prior art. Claim 33 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Lu ('540) and the prior art and further in view of Aoi (U.S. Patent No. 6,333,257 B1). Claim 35, 36 and 45 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Lu ('540) and further in view of Jeng (U.S. Patent No. 6,054,769). Claims 39 and 40 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Lu ('257) and further in view of Allada, et al. (U.S. Patent No. 6,218, 317 B1). Reconsideration is respectfully requested.

These rejections are respectfully traversed in view of the following discussion.

Entry of this § 1.116 Amendment is proper. Since the amendments above narrow the issues for appeal and since such features were in the claims earlier, such amendments do not raise

a new issue requiring further searching and/or consideration by the Examiner. As such entry of this Amendment is believed to be proper and is earnestly solicited.

It is noted that the amendments are made only to overcome the Examiner's non-statutory objections, and to more particularly define the invention and not for distinguishing the invention over the prior art, for narrowing the scope of the claims, or for any reason related to a statutory requirement for patentability.

It is further noted that, notwithstanding any claim amendments made herein, Applicant's intent is to encompass equivalents of all claim elements, even if amended herein or later during prosecution.

I. THE CLAIMED INVENTION

Applicant's invention, as disclosed and claimed, for example, by independent claim 1, and similarly independent claim 5, is directed to a semiconductor device having a multi-layered insulation film which includes a first insulation layer having an organic material with a dielectric constant which is lower than a silicon oxide dielectric constant, a second insulation layer including a polysiloxane compound having an Si-H group and formed on and adhering to a top of the first insulation layer, a third insulation layer comprising an inorganic material and formed on and adhering to a top of the second insulation layer, and a plurality of wires embedded in a groove formed in the multi-layered insulation film, the multi-layered insulation film being disposed between the wires. Importantly, the second insulation layer comprises a hydride organosiloxane. (See Page 7, lines 12-14; Page 8, lines 7-9; Page 16, lines 8-25; Page 21, line

12-Page 22, line 14; Page 23, lines 10-15; Page 25, lines 21-26; and Figures 1-4).

Similarly, independent claims 41 and 42, recite, in pertinent part, "the second insulation layer comprises a hydride organosiloxane. (See Page 7, lines 12-14; Page 8, lines 7-9; Page 16, lines 8-25; Page 21, line 12-Page 22, line 14; Page 23, lines 10-15; Page 25, lines 21-26; and Figures 1-4).

Conventional devices have a first layer composed of an organic material of low dielectric, i.e., an organic SOG film e.g., Methyl Silsesquioxane ("MSQ") coated with a layer composed of an inorganic protective film, e.g., silicon oxide film, without a second insulation layer including a hydride organosiloxane. However, the conventional art is not effective because peeling occurs at the interface of the inorganic protective film and the organic layer, and thus de-lamination due to insufficient adhesion produces cross-talk in the semiconductor device. (See Page 2, lines 12-27; and Page 6, line 23 - Page 2, line 4).

An aspect of the invention includes a second insulation layer which includes a hydride organosiloxane, which provides good interlayer adhesion between the first insulation layer and the third insulation layer, and thus effectively prevents peering of the three insulation layers from each other. (See Page 8, lines 7-9; Page 13, lines 1-7; Page 16, lines 8-25; Page 21, line 12-Page 22, line 14; Page 23, lines 10-15; Page 25, line 21-Page 26, line 9; and Figures 1-4).

As a result of this inventive structure, process yield is improved and the semiconductor device is highly reliable as the interfacial adhesion between the film with low dielectric constant (e.g., the first insulation layer) and protective film, (e.g., the second insulation, adhesive layer), is significantly improved, "without damaging the excellent dielectric, flatness and gap-filling

characteristics of the organic material of the low dielectric constant" while crosstalk is reduced. (See Page 6, lines 15-20; and Page 13, lines 1-7).

II. THE 35 U.S.C. § 112, SECOND PARAGRAPH, REJECTION

In response to the rejection, Applicant has amended dependent claim 46 as recited above. Accordingly, Applicant respectfully submits that claims particularly point and distinctly claim the subject matter of the invention, and thus fulfill the requirements of 35 U.S.C. § 112, second paragraph.

In view of the foregoing, the Examiner is respectfully requested to withdraw this rejection.

III. THE PRIOR ART REJECTIONS

A. The 35 USC § 102(e) Rejection Based on Lu, et al.

Lu, et al. ("Lu") fails to disclose, teach or suggest the features of independent claim 1, and similarly independent claims 5, 41 and 42, including that a second insulation layer which includes a hydride organosiloxane.

As noted above, in Applicant's invention (e.g., as defined in Claim 1), the semiconductor device includes a multi-layered insulation film including a first insulation layer 2, a second insulation layer 3 and third insulation layer 4. The second insulation layer 3 is formed on and adheres to a top of the first insulation layer 2, and the third insulation layer 4 is formed on and adheres to a top of the second insulation layer 2. The second insulation layer includes a hydride

organosiloxane, e.g., methylated hydrogen silsesquioxane, for example, as recited in claim 46. Thus, this structure provides good interlayer adhesion between the first insulation layer and the third insulation layer, and thus effectively prevents peering of the three insulation layers from each other. (See Page 8, lines 7-9; Page 13, lines 1-7; Page 16, lines 8-25; Page 21, line 12-Page 22, line 14; Page 23, lines 10-15; Page 25, line 21-Page 26, line 9).

Applicant agrees with the Examiner that Lu only teaches an adhesion layer comprised of hydrogen silsesquioxane, and does not teach or suggest a second insulation "using methylated hydrogen silsesquioxane film (MHSQ)," i.e., a hydride organosiloxane. (See Office Action, Page 3, lines 6-7; and Page 6, Section 8).

In particular, the above structure, and related molar ratio, of the second insulation layer, is not taught or suggested by Lu. That is, as shown in Figures 2b and 3f of Lu, Lu merely discloses an integrated circuit with a multilayered film formed on a silicon substrate 102. The multilayered film includes an xerogel, e.g., a silica xerogel, 242, 342 formed on the silicon substrate 102, an adhesion layer 144, 244, 344 formed on the xerogel 242, 342, and an oxide layer 246, 346 formed on the adhesion layer. The adhesion layer 144, 244,344 only appears to include conventional hydrogen silsesquioxane. However, as indicated above, Lu does not disclose or suggest that the adhesion layer includes a hydride organosiloxane, let alone, methylated hydrogen silsesquioxane. Accordingly, Applicant agrees with the Examiner that Lu does not disclose or suggest a second insulation layer which includes a hydride organosiloxane as claimed by Applicant. (See Office Action, Page 3, lines 6-7, and Page 6, Section 8; Lu at Abstract; Column 1, lines 33-61; Column 3, line 48-Column 6, line 62; and Figures 2b and 3f).

Indeed, this conventional integrated circuit dielectric provides a surface treatment for porous silica, i.e., the xerogel 342, to enhance adhesion of the subsequent overlying layers, i.e., the adhesion layer 344 and the oxide layer 346, whereas Applicant's invention is primarily focused on good interlayer adhesion between the first insulation layer and the third insulation layer, and thus effectively prevents peeling of the three insulation layers from each other. Accordingly, the interfacial adhesion between the film with low dielectric constant (e.g., the first insulation layer) and protective film, (e.g., the second insulation, adhesive layer), is significantly improved. Thus, Lu discloses that the multi-layered film includes an adhesion layer 344 formed from conventional hydrogen silsesquioxane, whereas Applicant's invention teaches that a second insulation layer includes a hydride organosiloxane. (See Page 6, lines 15-20; Page 8, lines 7-9; Page 13, lines 1-7; Page 16,lines 8-25; Page 21, line 12-Page 22, line 14; Page 23, lines 10-15; Page 25, line 21-Page 26, line 9; and Figures 1-4).

Thus, similar to the conventional art, the Lu structure may likely produce peeling at the interface of the adhesion layer 344 and the xerogel layer 342, and possibly between the adhesion layer 344 and the oxide layer 346, and this de-lamination due to insufficient adhesion may produce cross-talk in the semiconductor device. Therefore, Lu only teaches an integrated circuit dielectric, which provides a surface treatment for porous silica, i.e., the xerogel 342, in an attempt to enhance adhesion of the subsequent overlying layers.

However, this conventional structure is unsuitable for achieving at least one object of the invention, which is to which provides good interlayer adhesion between the first insulation layer and the third insulation layer, and thus effectively prevents peering of the three insulation layers

from each other. Thus, the inventive structure improves the process and reliability of the semiconductor device "without damaging the excellent dielectric, flatness and gap-filling characteristics of the organic material of the low dielectric constant." As a result, the semiconductor device has a minimum amount of crosstalk. (See Page 6, lines 15-20; Page 8, lines 7-9; Page 13, lines 1-7; Page 16, lines 8-25; Page 21, line 12-Page 22, line 14; Page 23, lines 10-15; Page 25, line 21-Page 26, line 9; and Figures 1-4).

For at least the reasons outlined above, Applicant respectfully submits that Lu does not teach or suggest all the features of Applicant's invention, including a second insulation layer which includes a hydride organosiloxane, as recited in independent claims 1, 5, 41 and 42, and related dependent claims 3, 4, 7, 8, 34, 37, 38, and 43-44.

Accordingly, Lu does not anticipate or render obvious the subject matter of claims 1, 3-5, 7, 8, 34, 37, 38, and 41-44. Withdrawal of the rejection of these claims under 35 U.S.C. § 102(e) as anticipated by Lu is respectfully requested.

B. The 35 USC § 103(a) Rejection Based on Lu, et al. in view of the Admitted Prior Art

Regarding claims 2, 6, 31 and 32, to make up for the deficiencies of Lu, the Examiner relies on the Applicant's Admitted Prior Art ("APA"). The APA fails to do so.

First, the APA, pertains to a process of forming a damascene copper wiring system of a low dielectric constant material. APA is specifically directed to decreasing inter-wire capacity in order to cope with the higher-speed operation of semiconductor devices. (See Application,

Background Section, Page 1, 2nd and 3rd Paragraphs, lines 8-15).

Nothing within APA, which focuses on decreasing the inter-wire capacity in order to cope with the higher-speed operation of semiconductor devices, has anything to with a surface treatment for porous silica to enhance adhesion of the subsequent overlying layers as disclosed in Lu. Thus, Lu teaches away from being combined with another invention such as, for example, APA.

Therefore, the urged combination would not have been made, absent hindsight.

Secondly, like Lu, the APA does not disclose, teach or suggest, including that a second insulation layer which includes a hydride organosiloxane as recited in independent claims 1 and 5.

Instead, Figures 6(a)-(c) of the APA merely disclose a curing system in which wires are formed in an insulation film having only two layers. The two layers include a first layer composed of an organic material of low dielectric, i.e., an organic SOG film, e.g., methyl silsesquioxane ("MSQ") coated with a layer composed of an inorganic protective film, e.g., silicon oxide film, without a second insulation layer, including a hydride organosiloxane. However, the APA is not effective because peeling occurs at the interface of the inorganic protective film and the organic layer, and thus de-lamination due to insufficient adhesion produces cross-talk in the semiconductor device. The Application specifically explains the problems with such a design, and how the present invention having a multi-layered film (e.g., including at least three layers) overcomes these problems. (See Page 2, lines 12-27; and Page 6, line 23 - Page 2, line 4).

Thus, APA would not have been combined with Lu, and does not teach or suggest,

including a second insulation layer comprised of a polysiloxane compound, let alone that the second insulation layer includes a hydride organosiloxane.

For the reasons stated above, the claimed invention, and the invention as cited in independent claims 1 and 5, and related dependent claims 2, 6, 31 and 32, should be fully patentable over the cited references.

C. The § 103(a) Rejection Based on Lu in view of the Admitted Prior Art and further in view of Aoi

Regarding claim 33, to make up for the deficiencies of Lu and APA, the Examiner relies on Aoi. The Aoi reference fails to do so.

First, Aoi pertains to an interconnection structure with an interlevel insulating film with a low dielectric constant. Aoi is specifically directed to improving adherence of an interlevel insulating film to an organic film, an oxide film or a metal film. (See Aoi at Abstract; Column 1, lines 1-13; and Column 3, lines 1-13).

Nothing within Aoi, which focuses on an interlevel insulating film with a low dielectric constant, with improved adherence to an organic film, an oxide film or a metal film, has anything to do with a surface treatment for porous silica to enhance adhesion of the subsequent overlying layers as disclosed in Lu. Further, nothing within Aoi, as indicated above, has anything to do with decreasing the inter-wire capacity in order to cope with the higher-speed operation of semiconductor devices as disclosed in the APA. (See Application, Background Section, Page 1, 2nd and 3rd Paragraphs, lines 8-15). Thus, Lu teaches away from being combined with another invention such as, for example, APA or Aoi.

Neither APA nor Aoi, separately, or in combination, has the same aim as Lu as discussed above, and the urged combination would not have been made, absent hindsight.

Secondly, like Lu and APA, Aoi does not disclose, teach or suggest, a second insulation layer which includes a hydride organosiloxane as recited in independent claim 1.

Further, Aoi does not disclose, teach or suggest, including the first insulation layer includes at least one of an organosiloxane and an aromatic-containing organic resin as recited in claim 2. Aoi also does not disclose, teach or suggest, including the aromatic-containing organic resin includes at least one of a polyaryl ether and a divinyl siloxane-bis-benzocyclobutene as recited in claim 33 of the invention.

Instead, Figures 4(a)-11(c) of Aoi merely disclose an interconnection structure in a semiconductor integrated circuit, including an interlevel insulating film. The structure includes a first metal interconnect 201, including a first silicon nitride film 202 formed over the first metal interconnect 201, a first organic-containing silicon dioxide film 203 formed on film 202, an organic film 204 formed on film 203, and a titanium nitride film 205 formed over film 204. (See Aoi, Column 9, line 52-Column 10, line 11).

In contrast, as discussed above, Applicant's invention includes a plurality of wires formed in a groove (e.g., respectively formed in a plurality of grooves) formed in a multi-layered insulation film, which includes three insulation layers, including a first insulation layer, a second insulation layer and third insulation layer where the composition of the second insulation layer 3 comprises a polysiloxane compound, and in particular, a hydride organosiloxane, for example, methylated hydrogen silsesquioxane not a first organic-containing silicon dioxide film 203, "in

which a phenyl group, bonded to a silicon atom, is introduced into silicon dioxide" as recited in Aoi. Accordingly, Aoi is deficient.

Thus, Aoi would not have been combined with Lu and APA, and does not teach or suggest, a second insulation layer which includes a hydride organosiloxane.

For the reasons stated above, the claimed invention, and the invention as cited in independent claim 1, and related dependent claims 2 and 33, should be fully patentable over the cited references.

D. The 35 USC § 103(a) Rejection Based on Lu, et al. in view of Jeng

Regarding claims 35, 36 and 45, to make up for the deficiencies of Lu, the Examiner relies on Jeng ("Jeng"). Jeng fails to do so.

First, Jeng pertains to low capacitance interconnect structures in integrated circuits having an adhesion and protective overlayer for low dielectric materials, which integrates polymer and other low dielectric constant materials into the integrated circuit substrates. Jeng is specifically directed to reducing capacitance between closely spaced interconnect lines of integrated circuits. (See Jeng at Abstract; Column 1, lines 35-45; and Column 2, lines 38-53).

Nothing within Jeng, which focuses on "improved adhesion between low dielectric constant materials and traditional inter-metal dielectric materials and protecting the low dielectric materials from subsequent processes," has anything to do with a surface treatment for porous silica to enhance adhesion of the subsequent overlying layers as disclosed in Lu. Thus, Lu teaches away from being combined with another invention such as, for example, Jeng.

Therefore, the urged combination would not have been made, absent hindsight.

Secondly, like Lu, Jeng does not disclose, teach or suggest, including that a second insulation layer which includes a hydride organosiloxane as recited in independent claim 1.

Further, Jeng does not disclose, teach or suggest, including the second insulation layer includes a first layer and a second layer placed in the first layer as recited in claim 35 of the invention. Jeng also does not disclose, teach or suggest, including the first insulation layer includes methyl silsesquioxane as recited in amended claim 36. Jeng further does not disclose, teach or suggest, including the second insulation layer is formed by one of a plasma CVD and a spin coating process where the semiconductor substrate is continuously maintained in a plasma atmosphere as recited in claim 45 of the invention. (See Page 15, lines 8-18).

Instead, Figures 1 and 2 of Jeng merely disclose a low capacitance interconnect structure in an integrated circuit having an adhesion layer 20 capping a silicon oxide layer 12 and a polymeric layer 18 where a silicon dioxide layer 22 covers the adhesion layer 20, and thus forms a protective overlayer for the polymeric low dielectric material 18. "The adhesion layer 20 is preferably hydrogen silsesquioxane (HSQ) as the prior art adhesion protection layers using organic silane are generally intolerant and decompose in the high temperature CVD process." (See Jeng, Column 4, line 43-Column 5, line 5; and Column 6, Table, lines 25-50). Accordingly, contrary to the assertion in the Office Action, Jeng only teaches a preference for HSQ, and does not disclose, teach or suggest, that the adhesion layer 20 is formed from a hydride organosiloxane.

Indeed, the Office Action does not provide or identify any specific citation in Jeng, which

discloses or expressly or impliedly suggests that the adhesion layer 20 can be formed from a hydride organosiloxane. Accordingly, the Office Action only generally asserts without any evidential support that the Jeng reference suggests the use of a hydride organosiloxane. Thus, the PTO's burden of establishing a prima facie case of obviousness does not appear to be met. (See MPEP Section 2142).

For emphasis, the Application specifically explains the problems with such a design, for example, as taught by Jeng, including the low resistance to chemical solutions and difficulty in forming the contact hole of the designated shape, and how the present invention having a multi-layered film (e.g., including at least three layers) overcomes these problems. Accordingly, Applicant teaches a second insulation layer comprised of a hydride organosiloxane, whereas Jeng only teaches only an adhesion layer formed from HSQ.

Please note, Jeng also does not teach a first insulation layer comprised of methyl silsesquioxane as recited in amended claim 36. (See Page 2, lines 12-27; and Page 5, line 22-Page 6, line 23).

Thus, Jeng would not have been combined with Lu, and does not teach or suggest including a second insulation layer comprised of a hydride organosiloxane.

For the reasons stated above, the claimed invention, and the invention as cited in independent claim 1, and related dependent claims 35, 36 and 45, should be fully patentable over the cited references.

E. The 35 USC § 103(a) Rejection Based on Lu, et al. in view of Allada, et al.

Regarding claim 39, which has been incorporated into independent claim 42, and claim

40, to make up for the deficiencies of Lu, the Examiner relies on Allada, et al. ("Allada"). Allada fails to do so.

First, Allada pertains to multilevel interconnects for integrated circuit devices, in particular, copper/dual damascene devices, and related fabrication methods. The interconnect integration eliminates "the need for removal of the wafer after formation of a polymeric interlayer dielectric to equipment for forming conventional oxide hardmasks on interlayer dielectrics." This invention is specifically directed to "increas[ing] device speed by reducing the effective dielectric constant in the stack, and the structures created thereby." (See Allada at Abstract; Column 1, lines 7-12; and Column 2, lines 5-25).

Nothing within Allada, which focuses on increasing device speed by reducing the effective dielectric constant in the stack, and the structures created thereby, has anything to with a surface treatment for porous silica to enhance adhesion of the subsequent overlying layers as disclosed in Lu. Thus, Lu teaches away from being combined with another invention such as, for example, Jeng.

Therefore, the urged combination would not have been made, absent hindsight.

Secondly, like Lu, Allada does not disclose, teach or suggest, including that a second insulation layer which includes a hydride organosiloxane as recited in independent claim 42.

Further, Allada does not disclose, teach or suggest, including the second insulation layer includes a methylated hydrogen silsesquioxane (MHSQ) film as recited in claim 39, which has been incorporated into independent claim 42 of the invention. Allada also does not disclose, teach or suggest, including the MHSQ film has a thickness of about 50 nm as recited in claim 40

of the invention.

Instead, Figures 1a-1b of Allada teach multilevel interconnects for integrated circuit devices, in particular, copper/dual damascene devices, and related fabrication methods. "Methylated-oxide type hardmasks 18 are formed over polymeric interlayer dielectric materials 16" where the hardmask and the interlayer dielectric may be spincoated. The "[d]ielectric layer 16 is etched and then electroplated with copper to produce the single damascene structure 10 with a copper line 20." Accordingly, a single metal copper line 20 is embedded in a recess formed between the methylated-oxide hardmask 18 and the interlayer dielectric material 16.

Methylated hardmasks 18 include an organic low-k hybrid organic siloxane polymer, i.e., Allied Signal's HOSP™ proprietary material. Applicant respectfully submits that the Examiner mischaracterizes the HOSP™ proprietary material as being the structural equivalent to the methylated hydrogen silsesquioxane (MHSQ) film. Indeed, Applicant teaches a second insulation layer comprised of methylated hydrogen silsesquioxane not a hardmask layer formed from an organic low-k hybrid organic siloxane polymer as taught by Allada.

Secondly, contrary to the assertion in the Office Action, the methylated hardmask 18, is more structurally and functionally equivalent to a hardmask layer (as the label indicates) not an insulating film with adhesive properties as suggested in the Office Action. (See Office Action, Page 6, Section 8; Allada, Column 2, line 8-Column 3, line 35).

Indeed, as indicated above, Applicant teaches the second insulation layer is formed from a hydride organosiloxane, e.g., MHSQ, to provide good interlayer adhesion between the first insulation layer and the third insulation layer, and thus effectively prevent peering of the three

insulation layers from each other. Allada does not anywhere teach or suggest this cause and effect relationship, particularly, as methylated oxide is used to form a layer 18, which functions as a hardmask not as an adhesive. (See Page 13, lines 1-7; Page 16, lines 8-25; Page 21, line 12-Page 22, line 14; Page 23, lines 10-15; Page 25, line 21-Page 26, line 9; and Figures 1-4).

For the reasons stated above, the claimed invention, and the invention as cited in independent claim 42, and related dependent claims 39 and 40, should be fully patentable over the cited references.

IV. FORMAL MATTERS AND CONCLUSION

In view of the foregoing, Applicant submits that claims 1, 2, 4-6, 8 and 31-46, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

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CERTIFICATION OF FACSIMILE TRANSMISSION

I hereby certify that the foregoing Amendment was filed via facsimile this 24th day of May, 2004, with the United States Patent and Trademark Office, Examiner Julio J. Maldonado, Group Art Unit # 2823, at fax number (703) 872-9306.

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